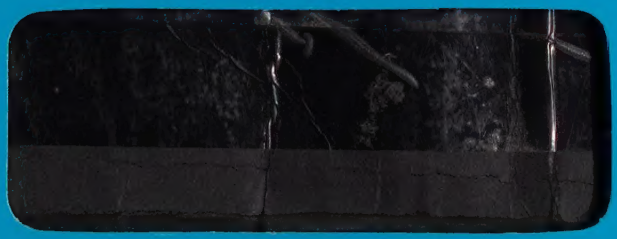
Operating and Service Manual



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GOULD BRUSH

MANUAL PART NO.
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D.C. PREAMPLIFIER
MODEL 13 4215 32

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Gould Model 13-4215-32 D. C. Amplifier (Figure 1-1) is a balanced to common medium gain d-c preamplifier with calibrated zero suppression.

This self-powered, single-channel preamplifier module provides a maximum sensitivity of 1mV/division on any Gould recording chart, regardless of channel width. It is both electrically and mechanically matched to any Gould recorder designed for use with 4200 or 4300 series modules. This signal conditioner is particularly valuable where calibrated zero suppression and a 5Hz cut-off are required.

A selector switch provides zero suppression ranges of +10, +1, −1, and −10 volts with the MULT (multiplier) switch in the X1 position——and correspondingly greater suppression voltages with the multiplier switch in the X100 position to a maximum of 500 volts. This feature offers true zero suppression by permitting cancellation of the static portion of the incoming complex signal and amplifying only the remaining dynamic portion. Suppression is constant throughout all sensitivity ranges. Sensitivity can be changed without altering the suppression setting. Zero-suppression accuracy is within 99.5% with multiplier in X1 position and 99.0% with multiplier set at X100. A vernier control provides stepless adjustment between discrete suppression steps.

The amplifier response is flat within 2% from d-c to 3K Hz with the output filter OFF. By means of a front-panel switch, a filter is introduced into the output circuit for attenuating high-frequency signal content: output is 3dB down at 5Hz with the filter switch on. This feature permits rejection of meaningless dynamic data or high-frequency noise.

This preamplifier is a fully enclosed, solid-state unit of rugged construction, incorporating aerospace components and assembly practices.

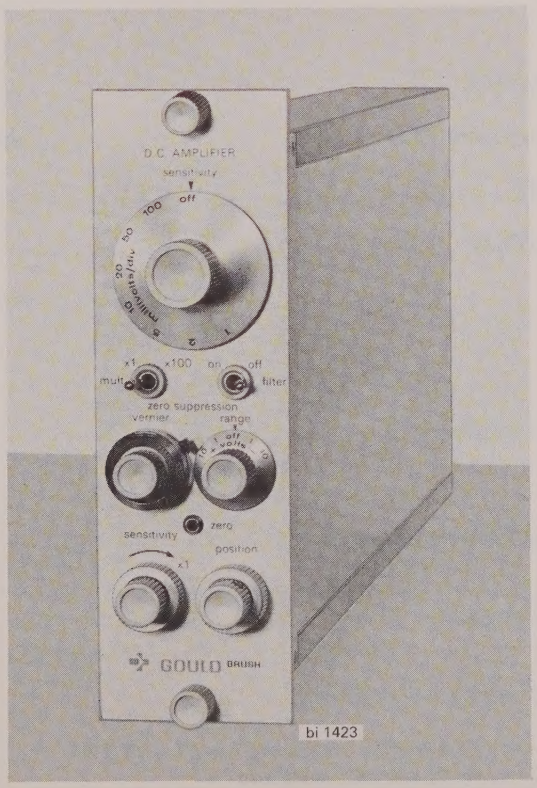


FIGURE 1-1 D.C. AMPLIFIER MODEL 13-4215-32

1.2 SPECIFICATIONS

Amplifier Input

Circuit	Balanced to common
Impedance	5 megohms, each terminal to common
Measurement Range	1mv/div to 500V full scale
Sensitivity Steps	1, 2, 5, 10, 20, 50, 100 mv/div and OFF X1, X100 multiplier
Variable Sensitivity	Minimum of 2.5 x multiplication of calibrated steps
Maximum Safe Voltage	500 volts peak, either input terminal to common or chassis 500 volts peak, common to chassis

Signal Output

Circuit	Single ended to common
Voltage	±2.5 volts into 2K ohms or greater
Inaccuracy	±1% of calibrated step
Non-Linearity	±0.1% of full scale
Impedance	Less than 10 ohms
Stability	
Zero with time	±1mv/24 hours after 15 minute warmup*
Zero with temperature	±200 microvolts/24 hours after 1 hour warmup*
Zero with line	300 microvolts for 10% line change*
Gain with time	0.05%/24 hours after 15 minute warmup
Gain with temperature	0.03%/°C – X1 position 0.05%/°C – X100 position
Gain with line	0.02% for 10% line change
Frequency Response	Flat within 2% from d-c to 3K Hz w/Filter OFF Less than 3dB down at 10K Hz 3dB down at 5K Hz w/Filter ON
Noise	Suppression off, less than 200 microvolts peak-to-peak D.C. to 100 Hz, RS = 50K*
	Suppression on, less than 1 mv peak-to-peak D.C. to 100 Hz, RS = 50K*
	Less than 2 mv peak-to-peak D.C. to 10K Hz, RS = 50K*

***NOTE: These are values referred to the amplifier input in the X1 multiplier position. the X100 position will multiply these values by 100.**

Common Mode Rejection

Input 1 and 2 to common	70 dB min at 50 mv to 200 mv sensitivity 60 dB typical at other settings
Common to chassis	Greater than 80 dB
Linear Common Mode Range (Input 1 and 2 to common)	X1 position – ±10V X100 position – ±500V

Zero Suppression

Range	+10, +1, OFF, –1, –10 volts Multiplied by MULT switch. (maximum 500 volts)
Inaccuracy	±0.5% in X1 position ±1% in X100 position
Non-Linearity	±0.5% of full suppression range
Resolution	±0.1% of full suppression range
Stability	
With time	±0.02%/week
With temperature	±0.01%/°C – X1 setting ±0.03%/°C – X100 setting
With line	±0.02% for 10% line change
Noise	0.02% of full scale, d-c – 100 Hz

Filter

Cutoff Frequency	–3 dB at 5Hz (±20%)
Rolloff	–12dB/octave
A.C. Power Input	115V ±10% or 230V ±10%, 50 to 400 Hz 5 watts nominal

Environment

Storage Temperature	–40°C to +85°C
Operating Temperature	0°C to +50°C
Temperature within specification	10 to 40°C
Humidity	95% at 32°C

1.3 SUPPLIES AND ACCESSORIES

Input Connector	231977-910
Fuse, 1/16 amp, slo-blo	264798-3

SECTION II

INSTALLATION

2.1 GENERAL

This section describes the checks and inspections that should be made upon receipt of the Gould D.C. Preamplifier, Model 13-4215-32; installation procedures, signal input connections, and outline dimensions.

2.2 INITIAL INSPECTION

Before attempting any electrical connections or operation, visually examine unit for broken or loose knobs, broken or chipped rear connectors, and dented or nicked panels.

2.3 INSTALLATION

Preamplifier Model 13-4215-32 may be rack mounted in any 19" RETMA cabinet by using preamplifier frame, Model 11-4588-12 or mounted in a portable carrying case for either 2, 4, or 6 preamplifiers. (see Table 2-1)

TABLE 2-1 PORTABLE CARRYING CASE

CASE	PREAMPLIFIERS
11-4123-10	2
11-4143-10	4
11-4163-10	6

a. Insertion

To Install preamplifier in either rack or carrying case:

1. Slide assembly into enclosure until rear connectors engage and front panel is tight against rack.
2. Tighten two knurled screws on front panel to secure unit.

b. Removal

To remove preamplifier from either rack or carrying case:

1. Loosen two knurled screws on front panel.
2. Carefully slide entire assembly out of enclosure.

2.4 SIGNAL CONNECTIONS

a. General

Gould Preamplifier Model 13-4215-32 is a direct coupled, balanced to common d-c preamplifier. Input and output circuits are isolated from chassis but there is no voltage or current isolation between input and output as illustrated in Figure 2-1.

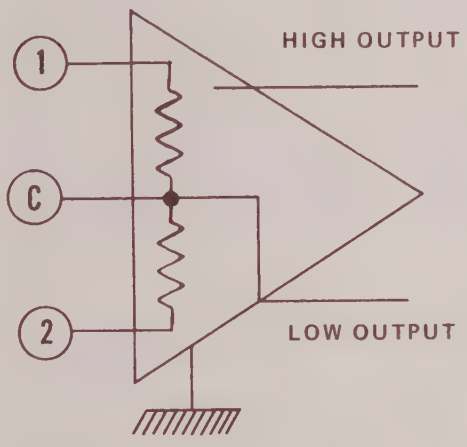


FIGURE 2-1 AMPLIFIER CIRCUIT DIAGRAM

This preamplifier can be used with any signal input level up to 500 volts, from sources which are floating, balanced to ground, or single ended. However, the following signal grounding procedures must be observed to avoid developing more or less than one ground point and the resulting noise pick-up.

SIGNAL SOURCE TYPE	SIGNAL CONNECTION PROCEDURE
Floating	Connect amplifier input terminals (C) and (2) Figure 2-1 (pins 6 and 1 on P-201) to chassis ground
Balanced to ground	Connect amplifier output to ungrounded load
Single ended to ground	Connect amplifier output to ungrounded load

If either the common input lead or the low side output lead is grounded the balanced to common amplifier becomes balanced to ground. For further details on the operation of balanced to common or balanced to ground amplifiers, identification of signal sources, elimination of ground loops, or typical signal connection diagrams, see Section VI Signal Sources in this manual.

b. Signal Input Connections

NOTE: For signal input connections, always use special shielded connector provided with the preamplifier (Brush part number 231977-910).

Connections to Gould Preamplifiers should be made using a good two-wire shielded cable. (Belden 8451, Brush part number 232434). Wire connector per schematic 281810 in rear of manual. High side of signal to pin 2 of P-201 and low side to pin 6 of P-201.

c. Output and Power

The Gould Medium Gain Preamplifier Model 13-4215-32 is designed to operate at a line voltage of 115/230 V a-c ±10%, 50 to 400 Hz. Before applying operating power, be sure voltage selector switch (Figure 2-2) is positioned to proper line voltage.

Output and power connections are provided thru a 16 pin connector on rear of preamplifier. The mating connector (Gould part number 123837) which is part of mounting frame, is pre-wired to accept any Brush coupler/preamplifier combination.

NOTE: It is important that pin 4 of output connector be connected to a good earth ground. If unit is installed in a Brush mounting frame or carrying case, be sure unit is connected by a three-wire grounded power cable.

The Gould preamplifiers provide an output signal to the Gould oscillograph (pin 1, common, pin 9, signal). An additional output is provided on pin 15 for operating FM tape recorder, oscilloscopes, and other auxiliary readout devices. This output is always the opposite polarity of the output on pin 9.

To make use of this output, a two conductor cable should be connected to pin 1 (common) and pin 15 (signal).

2.5 OUTLINE DIMENSIONS

Refer to drawing 280778 for outline dimensions.

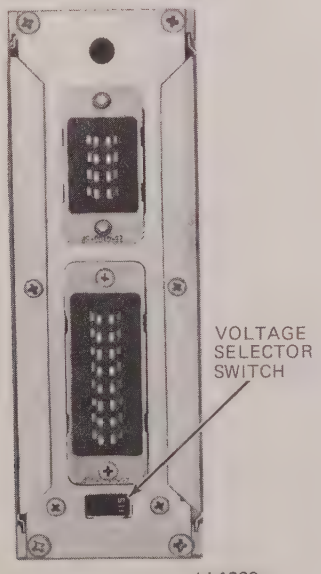


FIGURE 2-2 SIGNAL CONNECTORS AND VOLTAGE SELECTOR SWITCH

SECTION III

OPERATION

3.1 GENERAL

This section describes and illustrates the controls of the medium gain preamplifier Model 13-4215-32 and provides proper operating instructions.

3.2 CONTROL DESCRIPTION

NOTE: The item numbers below refer to the circled numbers in Figure 3-1.

ITEM NO	CONTROL	DESCRIPTION
1	SENSITIVITY	An eight position rotary switch permits selection of 1, 2, 5, 10, 20, 50, 100 millivolts per division overall system sensitivity and OFF. **NOTE: OFF position does not remove operating power.**
2	X1/X100 MULT (multiplier) switch	Permits selecting sensitivities of 100 times indicated control markings. Sensitivities become 100, 200, 500 millivolts, 1, 2, 5, 10 volts per division.
3	SENSITIVITY X1	Provides intermediate sensitivies between fixed settings of SENSITIVITY control. When in the full clockwise (detent) position, the sensitivity is fixed as indicated on SENSITIVITY control. When rotated counterclockwise, the sensitivity decreases from that indicated on SENSITIVITY control. A ratio of 2.5 to 1 provides overlapping gain. This control is fitted with a locking nut to prevent inadvertent turning.
4	ZERO Adjustment	Permits zeroing of amplifier output.
5	Pen POSITION	Permits positioning pen across width of channel, ±28 divisions, minimum. This control is fitted with a locking knob to prevent inadvertent turning.
6	ZERO SUPPRESSION Range	Permits selecting −10.0, −1.0, +1.0, +10.0 volts for calibrated zero suppression, and OFF. **NOTE: When X1/X100 multiplier switch is in X100 position, range is −1000, −100, +100, +1000 volts and OFF. (Maximum input voltage is 500 volts).**
7	ZERO SUPPRESSION Vernier . . .	Permits accurate setting of zero suppression voltages. Dial reading is percentage of voltage selected on range switch. **NOTE: 10.0 (extreme clockwise) is 100% of suppression voltage selected.**
8	FILTER ON–OFF	A two-position toggle switch. Inserts a 60 Hz filter into the circuit in the ON position.
9	115V–230V Slide Switch . . . . . (Refer to Figure 2-2)	Permits the amplifier to be used in either 115volt or 230volt systems.

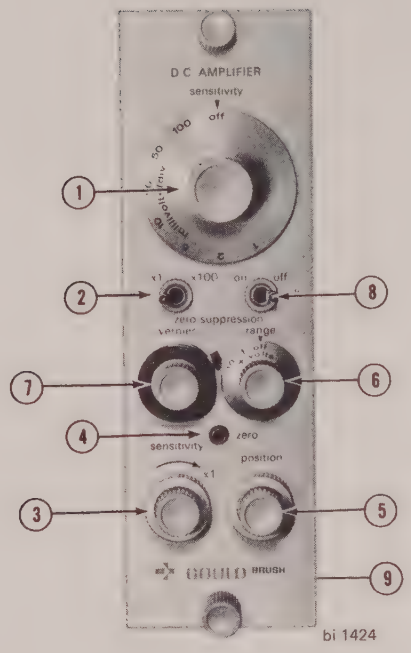


FIGURE 3-1 FRONT PANEL CONTROLS

NOTE: When using this amplifier in conjunction with a recorder which contains its own built-in preamplifier, pen POSITION control, attenuator (SENSITIVITY) control, such as on a Gould 220, or 260, it is important that the controls on the recorder be pre-set and controls on the amplifier be used. To correctly set controls for proper operation, proceed as follows:

1. **Set recorder SENSITIVITY to OFF position.**
2. **Adjust recorder PEN POSITION to chart center and lock knob.**
3. **Check that recorder vernier SENSITIVITY X1 control is in detent position, and lock knob.**
4. **Set recorder SENSITIVITY to 100 MILLIVOLTS PER DIVISION.**
5. **Proceed with normal amplifier operation, Paragraph 3.3.**

3.3 PRELIMINARY OPERATION

CAUTION: CHECK TO BE SURE ALL PROCEDURES IN SECTION II, INSTALLATION, HAVE BEEN PERFORMED.

1. Set SENSITIVITY to OFF position.
2. Place X1/X100 switch in X1 position.
3. Turn SENSITIVITY X1 control to full clockwise position (detent) and secure with locking knob.
4. Place pen POSITION control at approximate center position.
5. Set ZERO SUPPRESSION range switch to OFF.
6. Turn ZERO SUPPRESSION vernier control to 0.0, full counterclockwise, and lock.

7. Apply system power.

8. Operate oscillograph at moderate chart speed.

9. Adjust pen POSITION control to place pen at chart center and secure with locking knob.

10. Stop recorder and connect input signal to preamplifier.

11. Recorder is now ready for normal operation.

3.4 OFF – CENTER ZERO OPERATION

It is often desirable to record signals which always appear on one side of zero. In such cases, the pen POSITION control is used to displace the output reference voltage. Displacement may be as much as 2.5 volts either side of zero. Operation in this manner does not affect the performance of the preamplifier. Specifications remain unchanged.

3.4 UNCALIBRATED OPERATION

To obtain more useful records, it may be desirable to operate the amplifier with the SENSITIVITY X1 vernier control backed-off from the X1 (detent) position. The only specification affected by operating the instrument in this manner is the calibrated sensitivity. All other specifications remain unchanged.

3.6 USING CALIBRATED ZERO SUPPRESSION

a. General

Zero suppression permits the d-c component of a complex wave to be suppressed or bucked out, allowing the dynamic component to be amplified and recorded in greater detail. Calibrated zero suppression indicates the exact magnitude of that d-c voltage which has been suppressed. Location of the zero suppression system between the X1/X100 switch and the amplifier's attenuator provides calibrated zero suppression that is independent of both amplifier sensitivity and attenuator setting. This valuable feature permits amplifier sensitivity and attenuator settings to be changed at any time without resetting zero suppression controls. Zener regulated zero suppression voltage and temperature compensated components assure stable zero suppression readings.

The effective use of calibrated zero suppression can best be explained by describing two typical applications.

b. Application No. 1

To determine the character of a medium level complex signal which contains a positive static component, plus one or more dynamic components, proceed as follows:

1. Turn SENSITIVITY control to OFF position.

2. Place X1/X100 switch in the X1 position.

3. Turn ZERO SUPPRESSION vernier to full counterclockwise position.

4. Turn SENSITIVITY X1 control to the X1 (detent) position.

5. Operate chart at 5 millimeters per second and use pen POSITION control to set pen at chart center.

6. Advance SENSITIVITY control clockwise until pen approaches edge of chart. Note that the signal amplitude is less than 1 volt.

7. Set ZERO SUPPRESSION range control at +1 volt position which will allow complete suppression of any static component up to 1 volt. Ten revolutions of the ZERO SUPPRESSION vernier now equal 1 volt; each revolution is equal to 100 millivolts and each dial division represents 2 millivolts.

8. Move dynamic component of signal to chart center by turning ZERO SUPPRESSION vernier clockwise.

9. Advance SENSITIVITY control clockwise as long as recorded trace increases in direct proportion to each increase in preamplifier sensitivity.

10. Read maximum peak-to-peak value of dynamic signal component from the recorder chart.

11. Use ZERO SUPPRESSION vernier to adjust dynamic signal component exactly to chart center.

NOTE: In situations where the SENSITIVITY control is at a high sensitivity position, the ability to set suppression at zero may be limited by the resolution of the ZERO SUPPRESSION vernier control.

12. From the ZERO SUPPRESSION vernier

control, read to three places the average d-c component of complex signal.

13. Run a short length of chart at 100 millimeters per second or higher and determine the predominating frequencies which made up the dynamic component of this complex signal.

c. Application No. 2

To be certain that calibrated zero suppression is thoroughly understood, this second example describes a medium level complex signal which has a large negative static component. Since signal amplitude is greater than 2.5 volts, the input signal multiplier (X1/X100 switch) will be used in X100 position. Since static component is negative, the ZERO SUPPRESSION range control, is set at an appropriate negative voltage position.

1. Turn SENSITIVITY control to OFF position.

2. Place X1/X100 switch in the X100 position.

3. Turn ZERO SUPPRESSION vernier to full counterclockwise position.

4. Turn SENSITIVITY X1 control to the X1 (detent) position.

5. Operate chart at 5 millimeters per second and use pen POSITION control to position pen at chart center.

6. Advance SENSITIVITY control clockwise until pen approaches edge of chart. Note that signal amplitude is slightly less than 100 volts.

7. Set ZERO SUPPRESSION range switch to −1 volt position. Since input signal multiplier (X1/X100 switch) has been set in X100 position, a static component up to 1000 volts may be completely suppressed. Ten revolutions of the ZERO SUPPRESSION vernier now equal −1000 volts; each revolution is equal to −100 volts and each dial division represents −0.2 volts.

NOTE: Zero suppression in the 10 volt range will be limited to the 500 volt maximum.

8. Turn ZERO SUPPRESSION vernier clockwise to bring dynamic component of signal to chart center.

9. Advance SENSITIVITY control clockwise as long as recorded trace increases directly in proportion to each increase in preamplifier sensitivity.

10. Read maximum peak-to-peak value of dynamic signal component from recorder chart.

11. Use ZERO SUPPRESSION vernier to bring dynamic signal component exactly to chart center.

NOTE: In situations where the SENSITIVITY control is a high sensitivity position the ability to set suppression at zero may be limited by the resolution of the ZERO SUPPRESSION vernier control.

12. The average d-c component of complex signal, to three places, is read from ZERO SUPPRESSION vernier control.

13. Run a short length of chart at 100 millimeters per second or higher and determine the predominating frequency which makes up the dynamic component of this complex signal.

3.7 FILTER OPERATION

To eliminate 60 Hz or higher frequency noise, perform the following:

1. Operate the amplifier as described in Para. 3.3.

2. Place the filter switch in the ON position.

NOTE: With the filter circuit in operation, a low frequency signal will also be impaired. For example: a 5 Hz filtered signal will be displayed on the chart paper at 0.7 times the unfiltered amplitude. The higher the frequency the greater the impairment.

3.8 ZERO OUTPUT ADJUSTMENT

During extended operation of amplifier 13-4215-32, it is advisable to check the amplifier zero position to assure accuracy of measurement without recalibration of the unit. To perform the zero check and correct the position if necessary use the following procedure:

1. Remove input signal and short amplifier inputs, pins 2 and 6 of P-201.

2. Set SENSITIVITY control to OFF.

3. Connect voltmeter to amplifier output, pins 1 and 9 of P-202.

4. Adjust pen POSITION control for 0.0 volts ±10mv output.

5. Set SENSITIVITY control to most sensitivity position.

6. Check output for 0.0 V d-c ±10 mv.

7. Adjust ZERO control on front panel if necessary to produce 0.0 volts ±10 mv output.

8. Set SENSITIVITY control to desired range.

9. Remove short from amplifier inputs and connect input signal.

10. Remove voltmeter from output connector.

11. Unit is now properly zeroed and ready for operation.

SECTION IV

THEORY OF OPERATION

4.1 GENERAL

The Medium Gain D.C. Amplifier Model 13-4215-32 consists of a divider network amplifier and gain attenuator with zero suppression, interstage sensitivity attenuator, and output amplifier with active filter network. Power for amplifiers and zero suppression is supplied by zener regulated power supplies. (see Figure 4-1)

4.2 DETAILED DESCRIPTION

a. Input Amplifier and Attenuator

A block diagram (Figure 4-2) and simplified schematic (Figure 4-3) illustrate the operation of the input section.

Amplifiers U-101 and U-102 are connected as non-inverting amplifiers to provide the high input impedance required by this amplifier. The amplifiers are connected by feedback resistors R-109 , R-143, and R-144 in such a way that any differential signal applied to their inputs is amplified by:

$$Av = 1 + \frac{R144 + R143}{R109}$$

while any common mode signal is amplified by a factor of one.

The resulting signal is then applied to the differential amplifier composed of integrated circuit U-103 and resistors R-145, R-147, R-148 and R-149. In this stage the common mode signal is rejected, while the differential signal is amplified by a factor of:

$$Av = \frac{R147}{R145}$$

and is converted into a single ended output signal.

The function of the input attenuator, composed of resistors R-101 thru R-105, is to extend the useful differential and common mode range of the amplifier. This attenuator presents a resistance of 5 megohms from each input terminal to common, and in the X100 position, divides the input signal by a factor of 100.

b. Output Amplifier and Attenuator

A simplified schematic of the output section is shown in Figure 4-4. The output amplifier is composed of operational amplifier U-104 and its

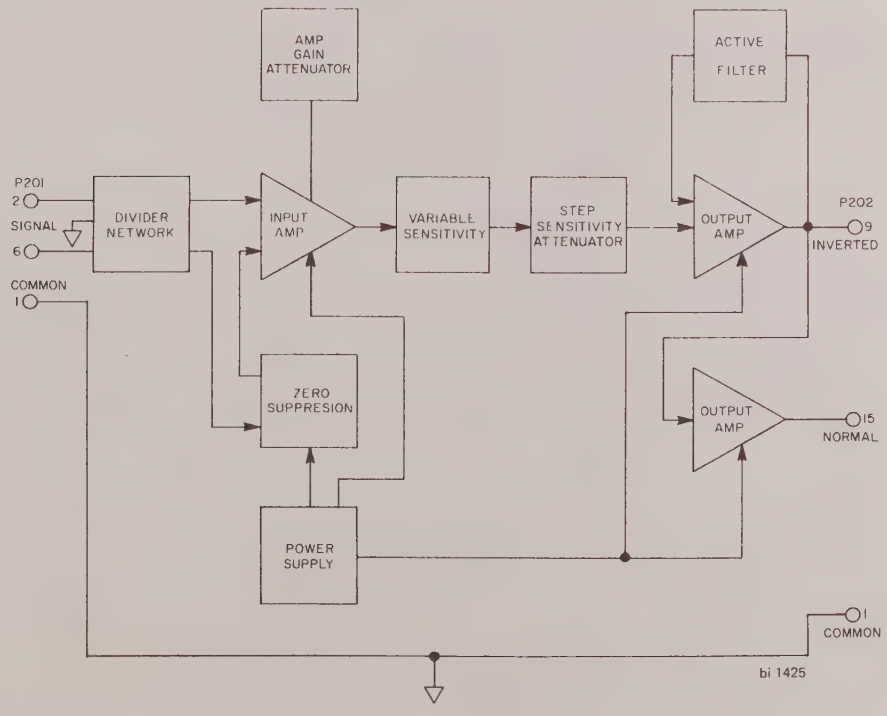


FIGURE 4-1 BLOCK DIAGRAM – D.C. AMPLIFIER 13-4215-32

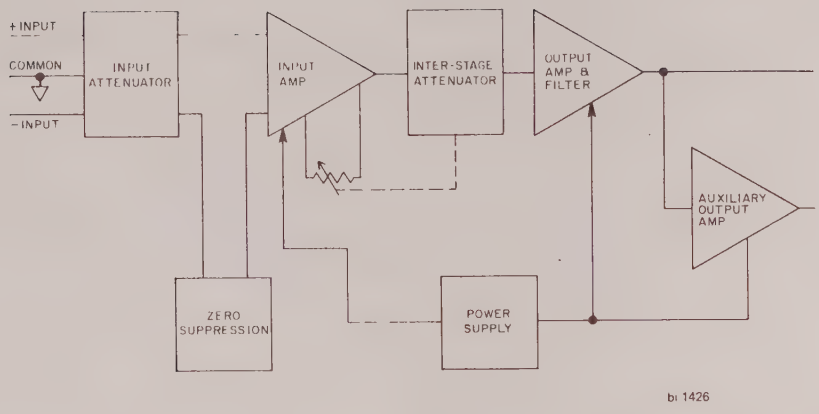


FIGURE 4-2 BLOCK DIAGRAM – INPUT AMPLIFIER AND ATTENUATOR

associated feedback elements. When the front panel filter switch is in the OFF position, capacitors C-101 thru C-104 are not in the circuit, forming an inverting amplifier whose gain is arrived at by:

$$Av = \frac{R115 + R116}{R113 + R114}$$

The front panel filter switch connects capacitors C-101 thru C-104 to the circuit as shown in Figure 4-4. In this configuration the circuit is an active filter with a low frequency gain of 10 until its response falls off 3dB at 5Hz. Beyond 5Hz the gain falls 12dB per octave so that an input signal of 50Hz would be attenuated by approximately 40 dB or 100 to 1.

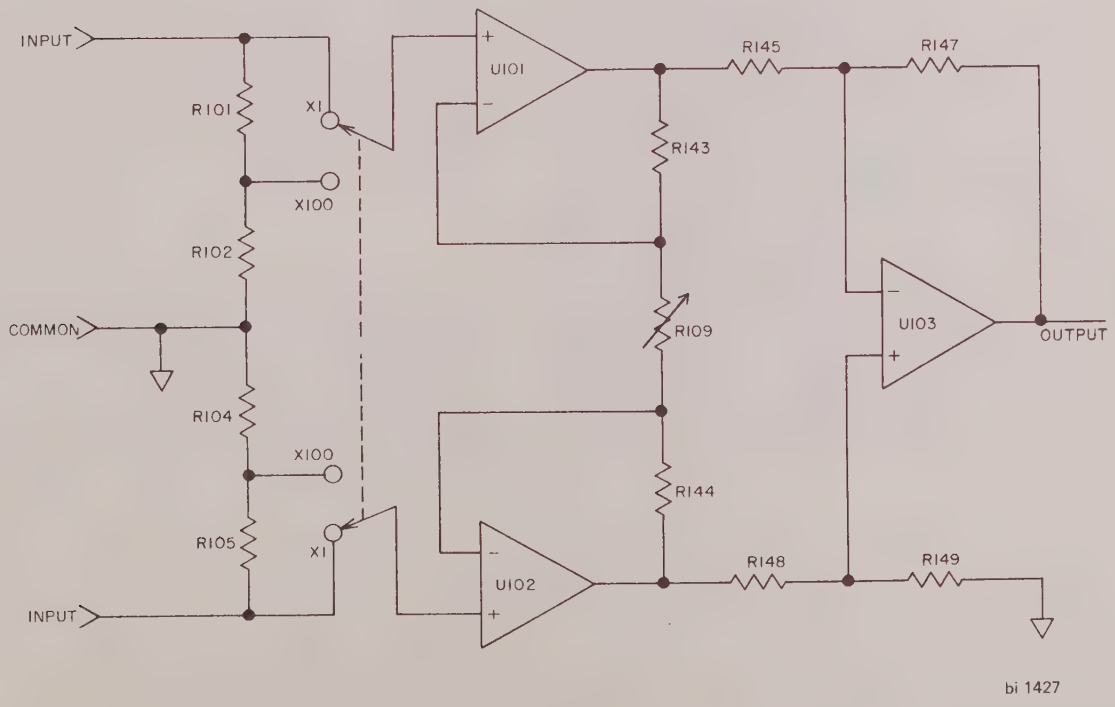


FIGURE 4-3 SIMPLIFIED SCHEMATIC – INPUT AMPLIFIER AND ATTENUATOR

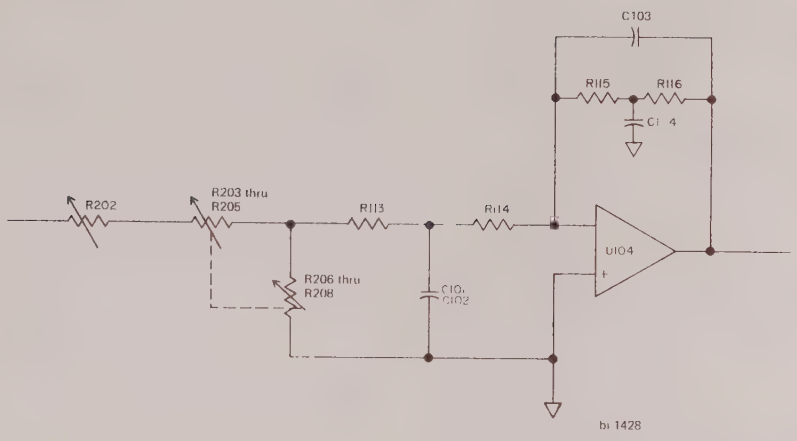


FIGURE 4-4 SIMPLIFIED SCHEMATIC – INTERSTAGE ATTENUATOR AND OUTPUT AMPLIFIER

Since the gain of the output amplifier IC-101 is fixed, the fixed sensitivity steps of the amplifier is developed by dividing the input signal to the amplifier by calibrated amounts. This is accomplished by the interstage attenuator composed of resistors R-203 thru R-208. The key feature of this attenuator is that while dividing the signal by various factors it always presents a constant 20K ohm input impedance. This factor is used to advantage by the variable sensitivity control R-202. Varying the SENSITIVITY X1 control R-202 places from 0 to 40K ohms in series with the output stage, thereby, achieving a continuously variable gain from the calibrated value of that step to approximately 2.5 times the calibrated value.

c. Power Supplies

The power for the amplifier is obtained through transformer T-101. Its output voltage is full wave rectified by bridge CR-105 then filtered by capacitors C-107 and C-108. The regulation is obtained by using transistors Q-102 and Q-103 as series pass transistors whose outputs are regulated by zener diodes CR-106 and CR-107. The resulting voltage is then used to power the internal amplifiers.

More highly regulated voltages of ±5.6V are needed to supply the position control and internal offset adjustments. These voltages are obtained from the ±18 volt supplies by the combination of resistors R-133 and R-135 and zener diodes CR-108 and CR-109.

An additional, highly isolated supply is required for the zero suppression circuit. The isolation is obtained through transformer T-102, the output of which is rectified by diodes CR-101 and CR-102 and filtered by capacitor C-106. Transistor Q-101 and its associated components act as a current source supplying the reference zener diode CR-104 and the network of resistor R-123 thru R-128. Zener diode CR-104 is temperature compensated which provides the stable reference voltage needed for the zero suppression circuit. The resistor network divides this voltage to the required 10 and 1 volt levels. Either of these voltages may be selected by S-205, ZERO SUPPRESSION switch, and applied to the ZERO SUPPRESSION vernier R-201, which in turn places a calibrated portion of the voltage in series with one input lead to suppress an equal portion of the input signal.

SECTION V

CALIBRATION

5.1 GENERAL

The Gould Medium Gain Amplifier, Model 13-4215-32, is built to the highest precision standards, featuring maximum operational efficiency and dependability. Although it has been accurately calibrated before shipment from factory and should give long trouble-free service, normal aging and/or replacement of parts may cause unit to require calibration. All calibration should be performed only by qualified technical personnel.

5.2 TEST EQUIPMENT REQUIRED

The following is a list of test equipment necessary for calibration:

a. Totalab, Brush 882187, or

General Purpose VOM (Triplett Model 630 or equivalent)

AC-DC Differential Voltmeter (John Fluke Model 803B or equivalent)

DC source 0.1% accuracy

Signal Generator (Wavetek Model 110 or equivalent)

Oscilloscope (Tektronix Model 531 or equivalent)

5.3 PRELIMINARY PROCEDURE

1. Remove right side cover from amplifier by removing phillips head screw from rear of amplifier and sliding cover out of retaining grooves.

2. Apply power to input connector, pins 12 and 13 and allow unit to warm up for 15 minutes.

3. Set amplifier front panel controls as follows:

CONTROL	POSITION
SENSITIVITY	OFF
X1/X100	X100
FILTER	OFF
ZERO SUPPRESSION range	OFF
ZERO SUPPRESSION vernier	0.0
SENSITIVITY X1	X1
POSITION	Midrange (locked)
ZERO	Midrange

5.4 CALIBRATION PROCEDURE

a. Offset Adjustment

1. Connect differential voltmeter to amplifier output pins 1 and 9 of connector P-202.

2. Short input leads pins 2 and 6 of connector P-201.

3. Adjust pen POSITION control for 0.0 volts ±10mv amplifier output.

4. Set SENSITIVITY control to 1 mv/div position.

5. Alternately adjust internal zero control R-142 (A, Figure 5-1) and offset adjustment R-134 (B,Figure 5-1) to maintain 0.0 volts ±10 mv on all ranges.

NOTE: Long term drift specifications permit this setting to drift ±20mv over 24 hours and 10mv per °C. Therefore some variation will be seen over the calibration period but it is normal.

b. 10 Volt Adjustments

1. Set SENSITIVITY control to OFF and X1/X100 switch to X1 position.

2. Apply a +10.0V d-c ±0.1% signal to amplifier input.

3. Set ZERO SUPPRESSION vernier to 10.0 and ZERO SUPPRESSION range switch to +10 VOLTS.

4. Adjust 10 volt adjustment R-125 (C, Figure 5-1) to bring output within 1 volt of zero.

5. Apply −10.0V d-c ±0.1% signal to amplifier input.

6. Set ZERO SUPPRESSION range switch to −10 VOLTS.

7. Output will remain within 3 volts of zero if zero suppression circuit is operating properly.

c. 1−Volt Adjustment

1. Set ZERO SUPPRESSION range switch to OFF.

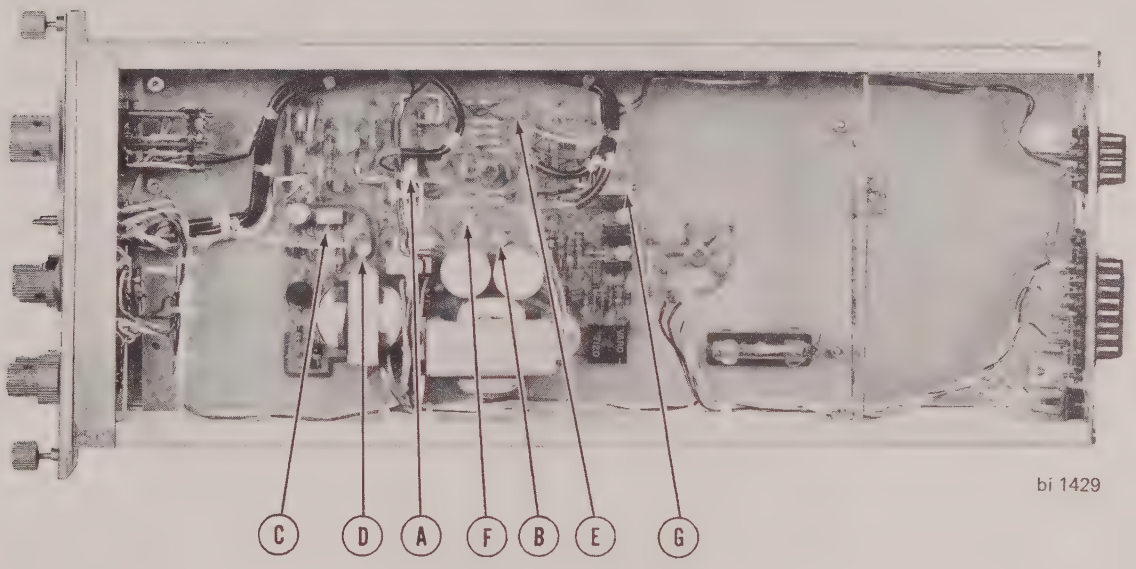


FIGURE 5-1 CALIBRATION CONTROLS

2. Set SENSITIVITY control to OFF.

3. Using pen POSITION, zero output.

4. Set SENSITIVITY to 1 mv/div position and short inputs.

5. If output is not 0.0 volts adjust internal zero adjustment R-142 (A, Figure 5-1) for 0.0 ±10 mv output.

6. Remove short from input and apply +1.0V d-c ±0.1%.

7. Set ZERO SUPPRESSION range switch to +1 volt.

8. Adjust 1 volt adjustment R-127 (D, Figure 5-1) to bring output within 300 millivolts of zero.

d. Gain Adjustment

1. Set controls per Paragraph 5.3.c.

2. Apply 5V a-c ±0.1% (rms) approximately 100 Hz to amplifier input.

3. Adjust pen POSITION control to zero output within 100 mv.

4. Set X1/X100 to X1 position.

5. Set SENSITIVITY control to 100 MV position.

6. Adjust 5V gain adjustment R-146 (E, Figure 5-1) for 5 volts ±25 mv output.

7. Apply the following a-c voltages ±0.1% to the amplifier input. With the SENSITIVITY switch set at the corresponding ranges. The output will be 5.0 volts ±25 mv if the gain is adjusted correctly.

INPUT VOLTAGE	SENSITIVITY RANGE
2.5 volts	50 mv
1 volt	20 mv
0.5 volts	10 mv
0.25 volts	5 mv
100 millivolts	2 mv
50 millivolts	1 mv

NOTE: The 5V adjustment may be readjusted slightly if necessary to make the above ranges meet the accuracy specification. The 100mv/div range must however, have 5V output within 25 mv with 5V applied to the input.

e. Common Mode Adjustment

1. Short amplifier inputs.
2. Connect oscilloscope to amplifier output.
3. Apply 20 volt peak-to-peak 60 Hz signal between inputs and common.
4. Set SENSITIVITY control to most sensitive position.
5. Adjust R-150, (F, Figure 5-1) for less than 500mv peak-to-peak output.
6. Switch X1/X100 switch to X100 position.
7. Apply 115 volt secondary of isolation transformer between input and common.
8. Adjust input balance adjustment R-103 (G, Figure 5-1) to obtain minimum signal on scope, less than 330 mv peak-to-peak.
9. Remove power from input connector.
10. Replace right side cover.
11. Unit is now calibrated and ready for operation.

SECTION VI

SIGNAL SOURCES

6.1 GENERAL

An understanding of signal sources, amplifier input configurations and signal connections in electrical measurement is vital to prevent noise or ambient conditions from overshadowing desired physical or electrical variables. Final data may be useless unless a signal source is properly selected or identified and used with an appropriate signal conditioning amplifier.

The following explanation of signal sources has been extracted from Gould Brush Applications booklet No. 101, SIGNAL CONDITIONING.

Signal Sources

Transducer or signal source selection is the first step in most measurement or recording applications. Low impedance devices are preferred, to reduce system noise and to minimize the shunting effect (loading) which the measuring instrument imposes on the source.

The signal source must be properly identified so that it can be matched with an appropriate amplifier. Signal sources fall into six classes, according to the configuration of the ouptut circuit. These are summarized as follows:

A SINGLE ENDED-GROUNDED signal source has two output terminals, one of which is connected to source ground as shown in Figure 1-A. The a-c line powered signal generator with a two terminal grounded output is typical.

A SINGLE ENDED-FLOATING signal source has two output terminals which are isolated from ground as shown in Figure 1-B. A FLOATING output can be grounded or reversed without disturbing the circuit. The dry cell battery, the output from a magnetic head, or a two terminal battery powered signal generator are typical examples.

A SINGLE ENDED-DRIVEN OFF GROUND signal source has two output terminals which are driven off ground by a second voltage, as shown in Figure 1-C. A DRIVEN OFF GROUND signal source can NEVER be grounded. A resistive shunt installed in the hot side of a power line or d-c bus for measuring current is a classic example.

A BALANCED-GROUNDED signal source has two active output terminals which have equal impedance to a common ground, as shown in Figure 1-D. The output terminals can be reversed without disturbing the circuit. A four arm wheatstone bridge output that is excited from a grounded power supply is a good example.

A BALANCED-FLOATING signal source is one that has two active output terminals which have equal impedance to common point that is floating, is shown in Figure 1-E. A four arm wheatstone bridge output that is excited from a FLOATING power supply or a center-tapped transformer secondary are typical examples. The output terminals can be reversed or the common terminal can be grounded without disturbing the circuit.

A BALANCED-DRIVEN OFF GROUND signal source has two active output terminals which have equal impedance to a common point which is driven off ground by a second voltage, is shown in Figure 1-F. The active output terminals can be reversed to invert signal polarity, but it can NEVER be grounded without disturbing or destroying the signal source. An example is a differential output amplifier which produces an output of ±30 volts, but operates at about +60 volts d-c off ground.

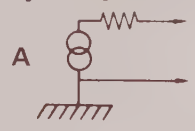
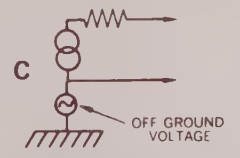
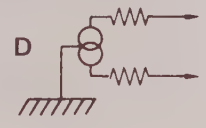
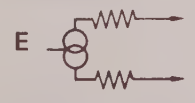
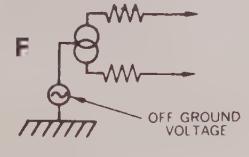
Source	Description	Examples
Single ended grounded 	Two output terminals one of which is connected to ground.	AC line powered signal generator.
Single ended—floating	Unbalanced output, isolated from ground. Can be grounded without disturbing circuit.	Dry cell battery. Magnetic tape head. Battery-powered signal generator.
Single ended—driven off ground 	Unbalanced output, driven off ground by second voltage source. Cannot be grounded.	Resistive shunt in hot side of line or bus for measuring current.
Balanced—grounded 	Terminals have equal impedance to common ground.	Four arm Wheatstone bridge, excited from grounded DC supply.
Balanced—floating 	Terminals have equal impedance to floating common point. Common point can be grounded without disturbing circuit.	Four arm Wheatstone bridge excited from floating DC supply. Center-tapped transformer.
Balanced—driven off ground 	Terminals have equal impedance to common point, driven off ground by a second voltage source. Cannot be grounded.	Differential output recorder amplifier (e.g., device with ±30 v output, operates in 0—60 v range).

Figure 1. Classification of Signal Sources

Identification of Signal Sources

If an electrical schematic is not available, a signal source may be identified by using one channel of a Brush recorder plus an ohmmeter. To identify a two-terminal source, the ground or low recorder input terminal is connected to a good solid ground at the signal source. With the source turned ON, the high side of the recorder input is connected to one output terminal of the signal source and then the other. The amplitude and character of these two measurements provide the required information about the source.

A zero signal from one signal source terminal and a usable signal from the other indicate a **single ended-grounded** source. Equal 60 Hz noise signals from both terminals indicate a floating source, and if there are only two terminals a floating source is probably **single ended-floating**. A resistance of several hundred megohms from each terminal to ground confirms that the source is floating. Usable but unequal signals from the two terminals indicate a driven off ground output. The average of the two signals is the off ground or common mode voltage, the difference is the signal amplitude. If the two-terminal source is turned OFF and the ohmmeter shows unequal resistance from the terminals to ground, the source is probably **single ended-driven off ground**. For all three source types, an ohmmeter across the two terminals with the source turned OFF indicates the source resistance.

To identify a three terminal signal source, the **ground** or **low** recorder input terminal is again grounded at the signal source. The **high** recorder terminal is connected to each of the three source output terminals in sequence.

A zero signal from one terminal and equal or similar signals from the other two indicates a **balanced-grounded** source. With the signal source turned OFF, resistance readings from ground to each terminal identify the ground terminal and the source resistance of each active output terminal to ground. Equal 60 Hz noise signals from the three terminals, and a resistance of several hundred megohms between all three terminals to ground, indicates a **balanced-floating** source. With the source turned OFF, ohmmeter readings across the three output terminals reveal the common terminal, the source resistance of each leg to common, and the total source resistance.

A usable signal from one terminal to ground and nearly equal signals from the other two, indicates a **driven off ground** source. The terminal with the minimum signal or a signal different from the other two is probably the common terminal, and the signal from it to ground is the off-ground or common mode voltage. With the source turned OFF, equal resistance readings to ground from any pair of terminals and a smaller resistance to ground from a third terminal confirms that the source is **balanced-driven off ground**. Resistance readings taken across the three output terminals reveal the common terminal, the output resistance of each leg to common and the total source resistance.

The Elusive Ground Loop

The GROUND LOOP is the largest source of electrical noise between electronic modules. More than one ground on a signal circuit or signal cable shield produces a common impedance coupling or ground loop between these two points. This generates large 60 Hz electrical noise currents which are in series and combined with the useful signal. The magnitude of ground loop current is directly proportional to the difference in absolute potential between the two grounds. In most cases a ground loop through either a cable shield or signal circuit will produce so much 60 Hz noise that it will obscure millivolt level signals.

Two separate grounds are seldom, if ever, at the same absolute voltage. This potential difference creates unwanted current in series with one of the signal leads. In Figure 2-A the potential difference between "Earth Ground No. 1" and "Earth Ground No. 2" produces ground loop current in the lower signal lead from the signal source to the input of the amplifier, causing ground loop noise to be combined with the useful signal. There is a second ground loop in Figure 2-A through the signal cable shield from the signal source to the amplifier. The ground loop current in the shield is coupled to the signal pair through the distributed capacity in the signal cable. This current is returned through the output impedance of the signal source and back to Earth Ground No. 1, adding a second source of noise to the useful signal. Either one of these ground loops is capable of generating a noise signal that is at least one hundred times larger than a typical millivolt level signal.

The amplifier shown in Figure 2-B is capable of being FLOATED a few volts off ground. The ground loop through the signal lead can be broken by simply lifting the amplifier grounding strap. The amplifier enclosure is still solidly grounded to "Earth Ground No. 2", but this will not create a ground loop, since the amplifier enclosure is insulated from the signal circuit. The ground loop through the signal cable shield is eliminated by removing the jumper from the cable shield to "Earth Ground No. 2". Now the signal source and the signal cable shield are grounded ONLY at the signal source, which is the proper configuration for minimum noise pickup.

In off-ground measurements, the signal cable shield should NOT be grounded. Effective shielding is secured by stabilizing the signal cable shield with respect to the useful signal. The signal cable should be connected to either the center tap or the low side of the signal source. Since the signal cable shield is being driven by an off-ground common mode voltage, it is necessary that the cable have appropriate insulation between the shield and the outside of the cable. THIS IS VERY IMPORTANT.

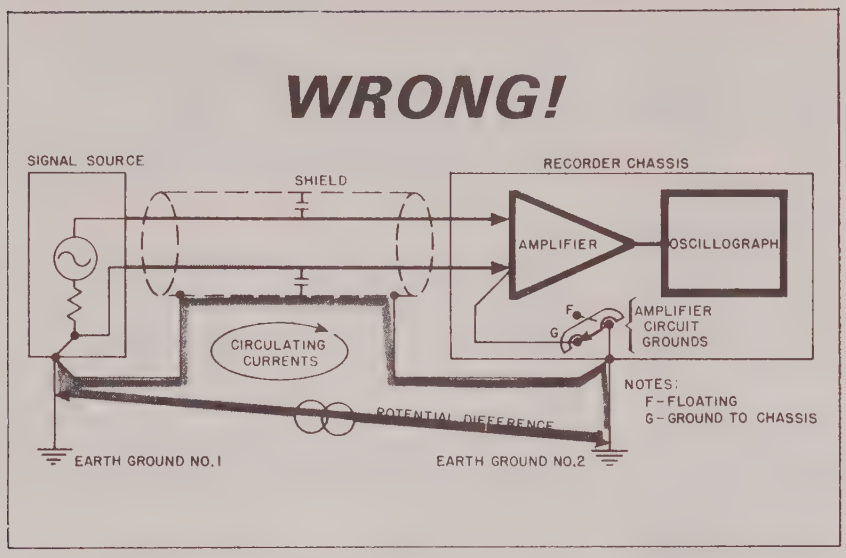


Figure 2A.

Typical ground loop is created by more than one ground on a signal circuit.

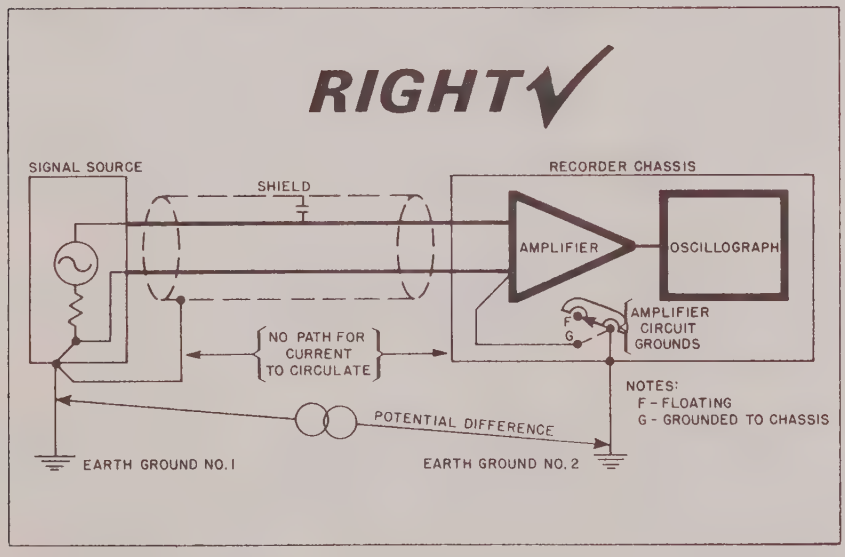


Figure 2B.

Ground loops are eliminated by turning amplifier input switch to FLOATING position and removing jumper from earth ground No. 2 to signal cable shield.

Recording system should have stable system ground
Signal circuit should never be grounded at more than one point
Signal cable shield should not be attached to more than one ground, and this ground should be at the signal source
More than one intentional or accidental ground on the signal circuit or signal cable shield will produce excessive electrical noise in any low level circuit
In off-ground recording, the signal cable shield should *not* be grounded; it should be connected to the center tap or the low side of the signal source

Figure 3.

Guide lines on Grounding

Amplifier Input Configurations

The SINGLE ENDED-GROUNDED AMPLIFIER has two input terminals, one of which is common with the output. This direct connection from the input to output is normally grounded through the third conductor in the a-c power cord. The amplifier enclosure is usually internally connected to this common point.

This type of amplifier works well with BALANCED-FLOATING signal sources or SINGLE ENDED-FLOATING signal sources, but it will NOT operate properly with any type of grounded signal source unless it is connected to the same ground as the amplifier, or unless one of the grounds is disconnected. Any difference in potential between the signal source ground and the amplifier ground WILL ADD TO OR SUBTRACT FROM the true value of the signal being measured. This erroneous noise signal is generally referred to as a "Ground Loop" and must be avoided.

The BALANCED TO GROUND AMPLIFIER has two active input terminals which have equal resistance to a common ground terminal. This common input terminal is firmly grounded through the third wire in the a-c power cord. Both the enclosure and the low side of the output are normally grounded to this same point inside the amplifier case. It can be operated as a "Balanced to Common" amplifier by removing the ground connection in the a-c power cord. In this case the amplifier would normally be connected to ONE ground at the signal source. It can also be operated as a "Single Ended-Grounded" amplifier by simply installing a ground strap from one active input terminal to ground.

The major limitation of a "Balanced to Ground" amplifier is its restricted off ground voltage capability which decreases as the input attenuator is advanced to a more sensitive position. This type of amplifier will work well with a SINGLE ENDED-FLOATING signal source, a BALANCED-FLOATING signal source and in most cases with a BALANCED-GROUNDED signal source.

The SINGLE ENDED-FLOATING AMPLIFIER has two input terminals that are electrically isolated from the output terminals. It is normally provided with an internal floating shield which is internally connected to the low side of the input. Both input terminals are free to float up or down in compliance with any common mode voltage that may appear at the signal source but the capacity to ground of the low input terminal is greater than the capacity to ground of its "hot" input terminal. It is therefore important to connect this amplifier so that any common mode voltage at the signal source is used to drive the low side of the input. The amplifier enclosure and the low side of the output are normally grounded through the third wire in the a-c power cord.

This type of amplifier works well with SINGLE ENDED-GROUNDED signal sources SINGLE ENDED-FLOATING sources or SINGLE ENDED-DRIVEN OFF GROUND sources and can be used down to millivolt levels with BALANCED- FLOATING signal sources.

The BALANCED, FLOATING AND GUARDED AMPLIFIER is the most sophisticated for all d-c amplifier types and can be used with all types of self-generating signal sources. Both input terminals are isolated from amplifier chassis and isolated from the output. The input terminals also have equal impedance to a third terminal called the Guard Shield or simply "GUARD", which is a full floating internal shield. The guard is used to minimize internal capacity from signal input terminals to chassis ground and to improve the a-c common mode rejection of the amplifier.

Both amplifier input terminals are free to float up or down in compliance with any common mode voltage that may appear at the signal source. Since both input terminals are floating and have very low capacity to chassis ground, the incoming signals may be GROUNDED, FLOATING or DRIVEN OFF-GROUND without affecting accuracy or system noise. When the guard shield is properly connected,

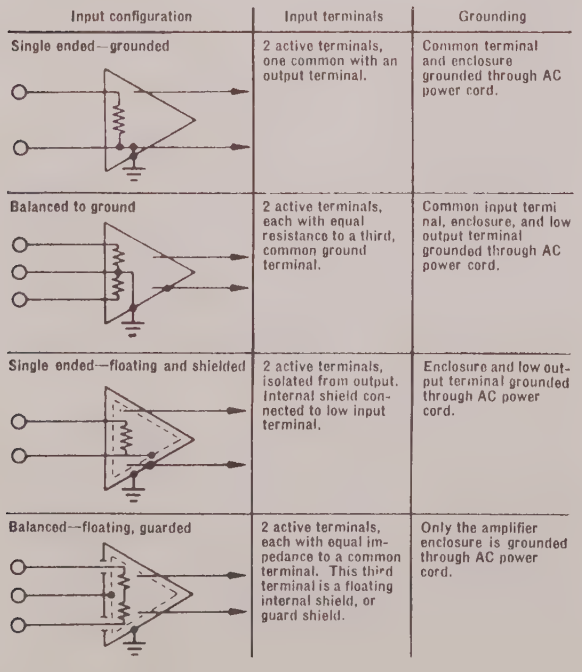

Input configuration
Input terminals
Grounding
Single ended—grounded
2 active terminals, one common with an output terminal.
Common terminal and enclosure grounded through AC power cord.
Balanced to ground
2 active terminals, each with equal resistance to a third, common ground terminal.
Common input terminal, enclosure, and low output terminal grounded through AC power cord.
Single ended—floating and shielded
2 active terminals, isolated from output. Internal shield connected to low input terminal.
Enclosure and low output terminal grounded through AC power cord.
Balanced—floating, guarded
2 active terminals, each with equal impedance to a common terminal. This third terminal is a floating internal shield, or guard shield.
Only the amplifier enclosure is grounded through AC power cord.

Figure 4. Classification of Amplifiers

the a-c noise rejection characteristics are quite good, so this amplifier can be used over a wide range of signal amplitudes, down to and including the microvolt level. The guard shield is NOT internally connected, but it is brought out to separate terminals in the amplifier input connector so that it may be properly connected for all types of signal sources.

Single Ended-Grounded Amplifier

When a "Single Ended-Grounded" amplifier is used with a SINGLE ENDED-FLOATING signal source, the low side of the source and the signal cable shield are connected to the grounded amplifier input terminal as shown in Figure 5. The other side of the source is connected to the "active" amplifier input terminal.

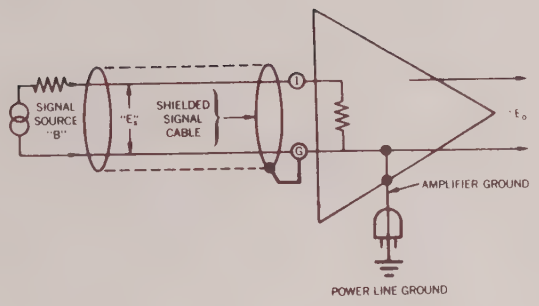


Figure 5. Single Ended-Grounded Amplifier. Operating grounded with floating signal source.

When a "Single Ended-Grounded" amplifier is used with a BALANCED-FLOATING signal source, the grounded amplifier input terminal may be connected to either side of the signal source. The other side of the source is connected to the "active" amplifier input terminal. The signal cable shield is connected to the grounded amplifier terminal as shown in Figure 6.

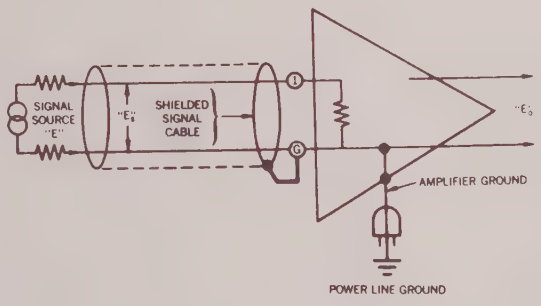


Figure 6. Single Ended-Grounded Amplifier. Operating grounded with floating signal source.

A "Single Ended-Grounded" amplifier can be operated at millivolt levels with a SINGLE ENDED-GROUNDED signal source provided one of the grounds is disconnected. Where possible, remove the ground at the source and connect the cable shield to the amplifier ground as shown in Figure 5. If this is not practical, the amplifier ground must be disconnected so the amplifier can float a few volts away from power line ground. It is done by using a ground isolation adapter on the a-c power plug. In this configuration, the grounded side of the signal source is connected to the amplifier ground terminal and the signal source is connected to the amplifier as shown in Figure 7. The amplifier enclosure is still grounded but to the signal source ground instead of the power line ground. When the source ground is used, all channels in a multichannel system must be connected to a common signal source ground.

The "Signal Ended-Grounded" amplifier is NOT appropriate for low-level applications because it has no common mode rejection and would therefore be quite noisy. It should NOT be used with a BALANCED-GROUNDED signal source because the amplifier ground would disturb or unbalance the source. It should NEVER be used with a DRIVEN OFF GROUND source because the "Single Ended-Grounded" amplifier input would destroy the source, or burn off the amplifier grounding connection or both.

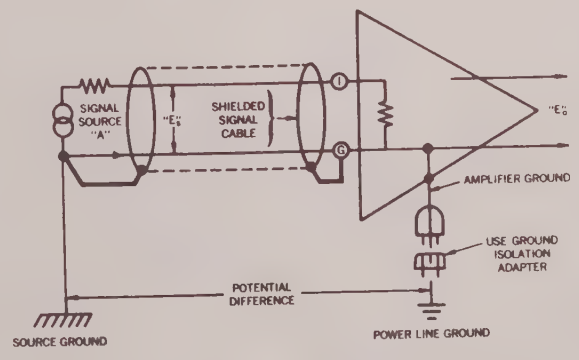


Figure 7. Single Ended-Grounded Amplifier. Operating floating from grounded signal source.

Balanced to Ground Amplifier

When a Balanced to Ground Amplifier is used with SINGLE ENDED-FLOATING or BALANCED-FLOATING signal sources, the two active amplifier input terminals are connected to both sides of the signal source. The connections can be reversed if a change in polarity is desired. The signal cable shield is connected to the grounded input terminal on the amplifier as shown in Figures 8 and 9. The optional ground strap shown in Figure 8 may be installed or omitted depending on which condition provides minimum electrical noise.

The BALANCED-GROUNDED signal source can be used with a "Balanced to Ground" amplifier and operated at full sensitivity if the potential difference between the signal source ground and the amplifier ground is quite small. In this case the difference in absolute potential between the signal source ground and the amplifier ground would show up as a common mode voltage as shown in Figure 10. For example, if the two grounds differed in absolute potential by 2.8 volts peak-to-peak and the amplifier has a common mode rejection of 1000:1 (60 dB) at 60 Hz, then 2.8 millivolts would show up as an error or noise signal at the amplifier input.

For this balanced to ground application the active amplifier input terminals are connected to both sides of the signal source. These connections can be reversed if a change in signal polarity is desired. The signal cable shield is connected to the grounded input terminal on the amplifier and to the grounded center tap on the signal source as shown in Figure 10. The common mode problem could be eliminated if it is possible to lift the ground at the signal source creating a balanced-floating input as shown in Figure 9, or by lifting the ground at the amplifier and operating as a "Balanced to Common" amplifier as shown in Figure 11. When the signal source ground is used, all channels in a multichannel system must be connected to a common source ground.

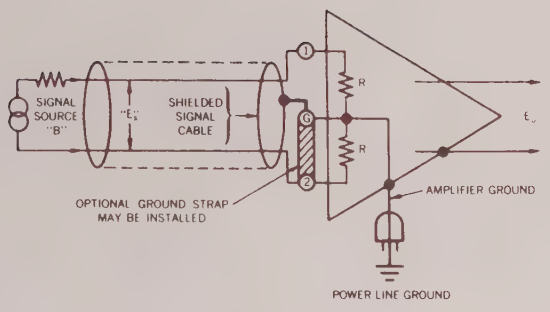


Figure 8. **Balanced to Ground Amplifier. Operating grounded with single ended-floating source.**

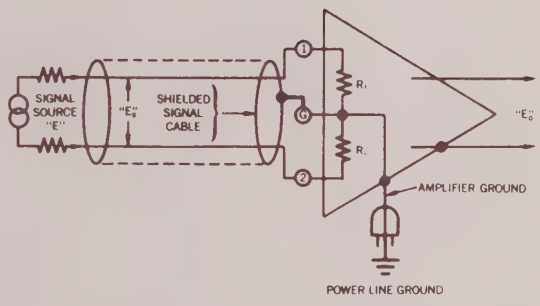


Figure 9. **Balanced to Ground Amplifier. Operating grounded with balanced-floating source.**

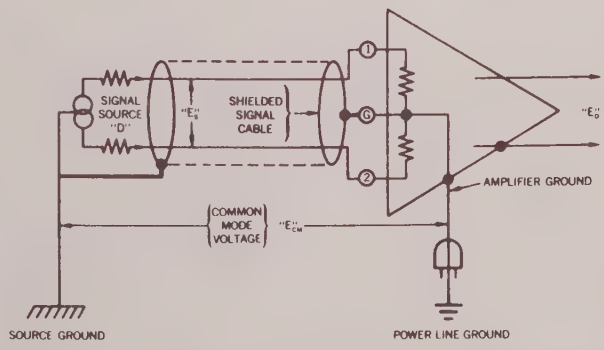


Figure 10. **Balanced to Ground Amplifier. Operating grounded with balanced-grounded signal source.**

The "Balanced to Ground" amplifier can NOT be used with a SINGLE ENDED-GROUNDED signal source. The best solution would be to remove the ground at the signal source and operate the amplifier "Single Ended-Grounded" as shown in Figure 8. If this is impractical, then the amplifier would have to be operated "Single Ended-Floating". This can be done by installing the ground strap from input terminal (2) to the ground terminal and then lifting the ground in the a-c power cord as shown in Figure 12. When the signal source ground is used, all channels in a multichannel system must be connected to a common source ground.

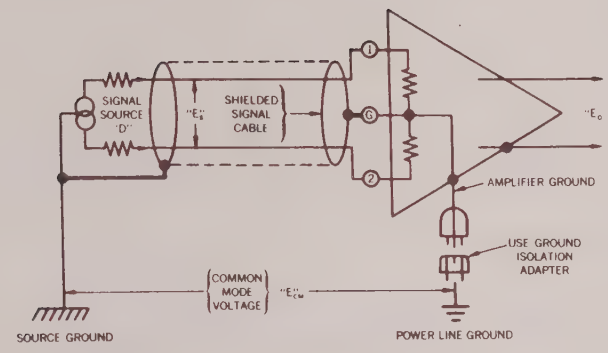


Figure 11. Balanced to Ground Amplifier. Operating floating with balanced grounded signal source.

The "Balanced to Ground" amplifier can be used in some LOW GAIN applications where the signal source is driven off ground by a common mode voltage as shown in Figure 13. The magnitude of the off ground voltage is limited by the maximum common mode voltage that is permitted on the amplifier at various sensitivity settings and by the amount of common voltage error that can be tolerated. For example a typical amplifier has a common mode rejection of 60 dB (1000:1) at 60 Hz which means that a 20 volt peak-to-peak common mode voltage would produce a 60 Hz error voltage of 20 millivolts. If the recorder sensitivity was 1.0 volt full scale (20 mv per chart div.) this would represent a common error of 2% of full scale which would probably be all right for most applications.

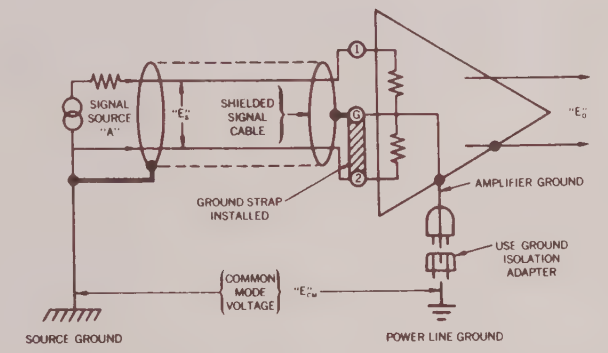


Figure 12. Balanced to Ground Amplifier. Operating floating with single ended-grounded source.

If the amplifier common mode rejection is 40 dB 100:1, the error would be 20% which can NOT be tolerated for any application. This problem could be resolved by operating the amplifier "Balanced to Common" as shown in Figure 11, providing the user is willing to assume the responsibility of operating the amplifier enclosure and output circuit 20 volts off ground. Otherwise an isolation amplifier would be required.

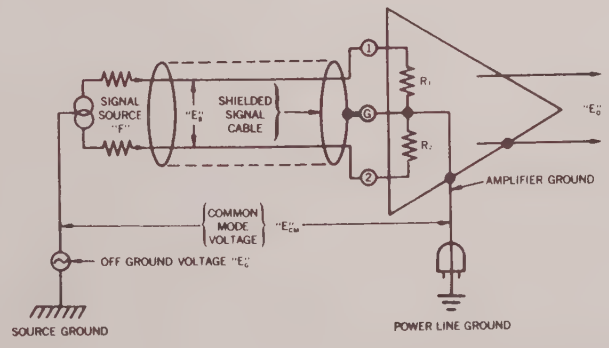


Figure 13. Balanced to Ground Amplifier. Operating grounded with balanced-driven off ground source.

SECTION VII
PARTS IDENTIFICATION

7.1 GENERAL

This instrument has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the instrument.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the instrument.

NOTE: Check to be sure the schematic number and revision letter stamped on the rear of the instrument agree with the number and revision letter on the schematic contained in this section.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name, model number, and serial number of the instrument.

   For Example: DC Preamplifier Model 13-4215-32, Serial Number_____

2. Description of the part as listed in the manual.

3. Gould part number

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

FIGURE 7-1
EXPLODED VIEW PARTS LIST
D.C. PREAMPLIFIER 13-4215-32

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	267995	Strap	
2	467997	Side Plate	
3	867998	Frame	
4	465913-48	Identification Plate	
	880807	Harness Assembly (includes items 5 thru 11)	
5	286151-3	Rotary Switch	S-205
	286152-1	Locking Washer (used on item 5)	
6	269960	Multiplier Switch (Toggle)	S-204
7	780771	Switch Asm.	S-203
8	261080-103	Variable Resistor	R-209
9	261079-403	Variable Resistor	R-202&S-202
10	269958	Filter Switch (Toggle)	S-201
11	230050-103	Variable Resistor	R-201
12	240819-4	Solder Lug	
13	123638	Connector	P-302
	240352-103	Capacitor (soldered to item 13)	C-201
14	768291	Bracket Subasm.	
15	247185	Slide Switch	S-206
16	280293	Rear Bracket	
17	880782	Board Asm. (See Fig. 7-2)	
18	269954-103	Variable Resistor	R-210
19	380770	Panel Bracket	
20	231182	Self-locking nut	
21	232275	Panel screw	
22	231183	Knob	
23	646451	Knob Asm.	
24	281992	Knob	
25	268655	Turn-counting knob	
26	240093	Plain-knurled nut	
27	680331	Knob asm.	
28	780782	Panel Asm.	
	13-119923-6202	Set Screw (used in all knobs)	

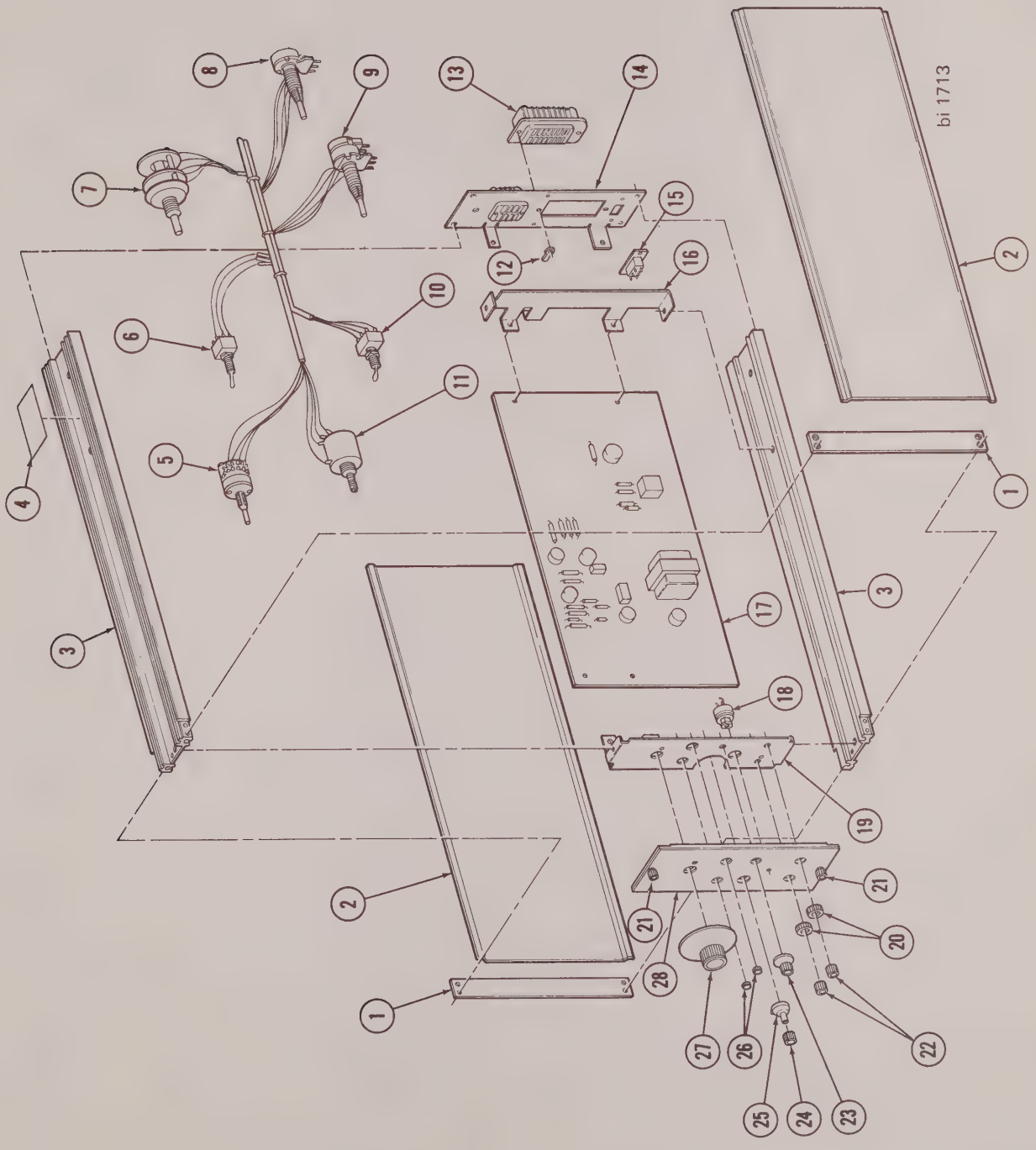


FIGURE 7-1 D.C. AMPLIFIER ASM. 13-4215-32

FIGURE 7-2
EXPLODED VIEW PARTS LIST
AMPLIFIER BOARD ASM. 880782

SYMBOL NO	PART NUMBER	DESCRIPTION
C-101	262585-106	Capacitor
C-102	262585-106	Capacitor
C-103	5-241145-224	Capacitor
C-104	5-241145-504	Capacitor
C-106	269255-107	Capacitor
C-107	230075-507	Capacitor
C-108	230075-507	Capacitor
C-109	280865-156	Capacitor
C-110	280865-156	Capacitor
C-111	240352-300	Capacitor
C-112	240352-150	Capacitor
C-115	240352-680	Capacitor
C-116	231462-102	Capacitor
C-117	231462-102	Capacitor
CR-101	231887	Diode
CR-102	231887	Diode
CR-103	249747	Diode, Zener
CR-104	247151-2	Diode, Zener
CR-105	265420-1	Semiconductor
CR-106	230061-4	Diode, Zener
CR-107	230061-4	Diode, Zener
CR-108	249747	Diode, Zener
CR-109	249747	Diode, Zener
F-201	266924-5	Fuse 1/16A Slo Blo
	232877	Fuse Holder
J	267235	Jumper Circuit
Q-101	240236	Transistor 2N1303
Q-102	230057-1	Transistor 2N4921
	269289	Heat Sink
Q-103	230058-1	Transistor 2N4918
	269289	Heat Sink
R-101	50-228823-1004	Resistor
R-102	25-265969-10001	Resistor
R-103	268940-201	Resistor, Variable
R-104	25-265969-10001	Resistor
R-105	50-228823-1004	Resistor
R-106	1-117802-2503	Resistor
R-107	1-117802-2503	Resistor
R-109	25-265969-22220	Resistor
R-113	25-265969-10001	Resistor

FIGURE 7-2
EXPLODED VIEW PARTS LIST
AMPLIFIER BOARD ASM. 880782

SYMBOL NO	PART NUMBER	DESCRIPTION
R-114	25-265969-10001	Resistor
R-115	25-265969-13002	Resistor
R-116	25-265969-70001	Resistor
R-117	50-128182-3333	Resistor
R-118	5-241111-183	Resistor
R-119	50-128182-2500	Resistor
R-120	25-265969-10001	Resistor
R-121	5-241111-153	Resistor
R-122	5-241111-153	Resistor
R-123	25-265969-50R00	Resistor
R-124	1-128182-4R00	Resistor
R-125	269085-201	Resistor
R-126	25-265969-900R0	Resistor
R-127	265843-100	Resistor
R-128	25-265969-98R00	Resistor
R-129	5-241111-100	Resistor
R-130	5-241111-100	Resistor
R-131	5-115557-561	Resistor
R-132	5-115557-561	Resistor
R-133	5-115557-182	Resistor
R-134	265843-103	Resistor
R-135	5-115557-182	Resistor
R-136	5-241111-104	Resistor
R-137	5-241111-221	Resistor
R-138	25-265969-10001	Resistor
R-139	5-241111-472	Resistor
R-140	25-265969-25002	Resistor
R-141	25-265969-25002	Resistor
R-142	269085-103	Resistor
R-146	265843-201	Resistor, Variable
R-149	25-265969-94000	Resistor
R-150	265843-501	Resistor
R-151	5-241111-152	Resistor
R-152	5-241111-152	Resistor
T-101	269293	Transformer
T-102	280503	Transformer
U-101	681087	Operational Amplifier(Matched Pair)
U-102	681087	Operational Amplifier(Matched Pair)
U-103	230062	Integrated Circuit
U-104	281287	Integrated Circuit
U-105	230062	Integrated Circuit

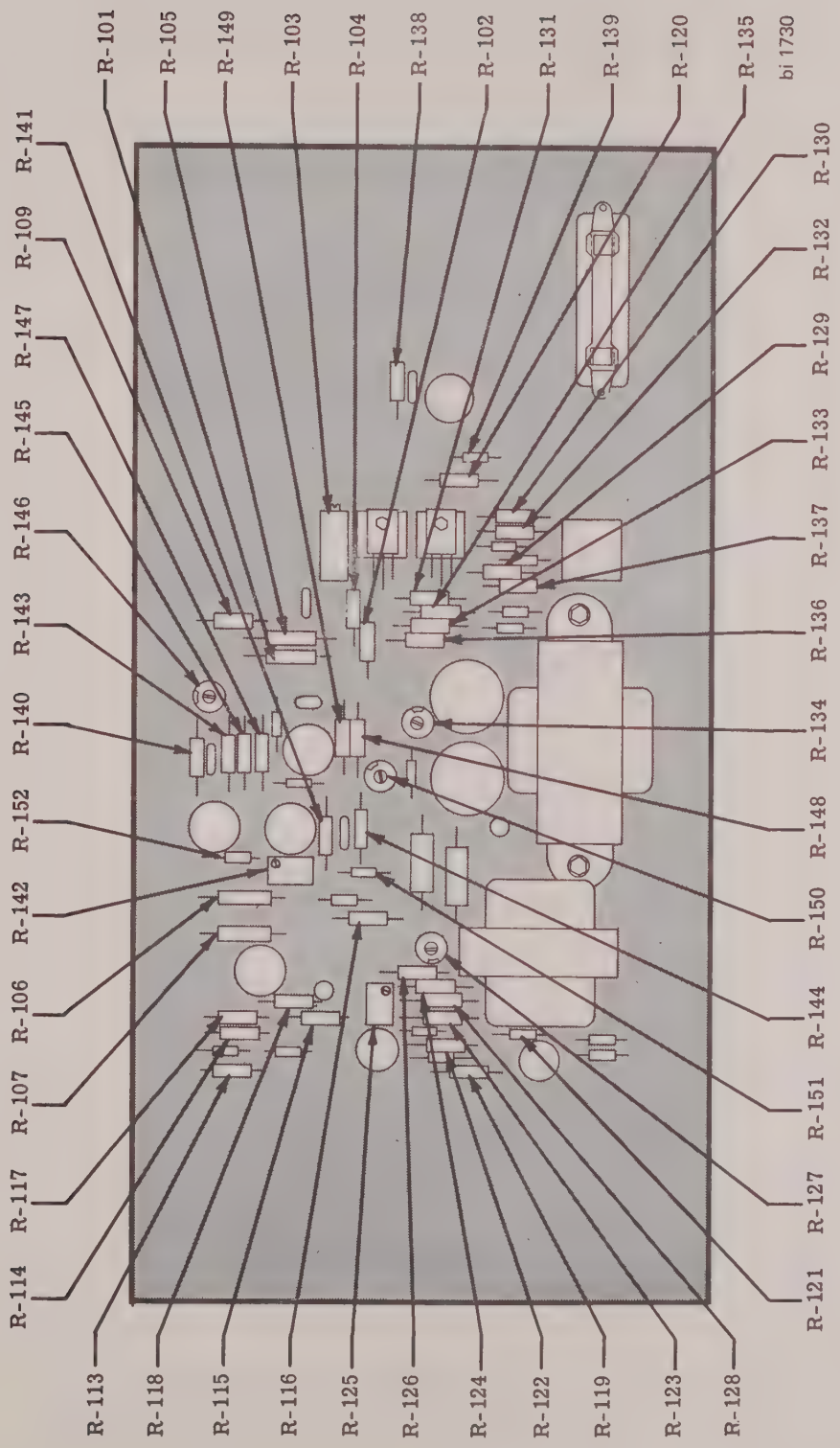


FIGURE 7-2A AMPLIFIER BOARD ASM. 880782

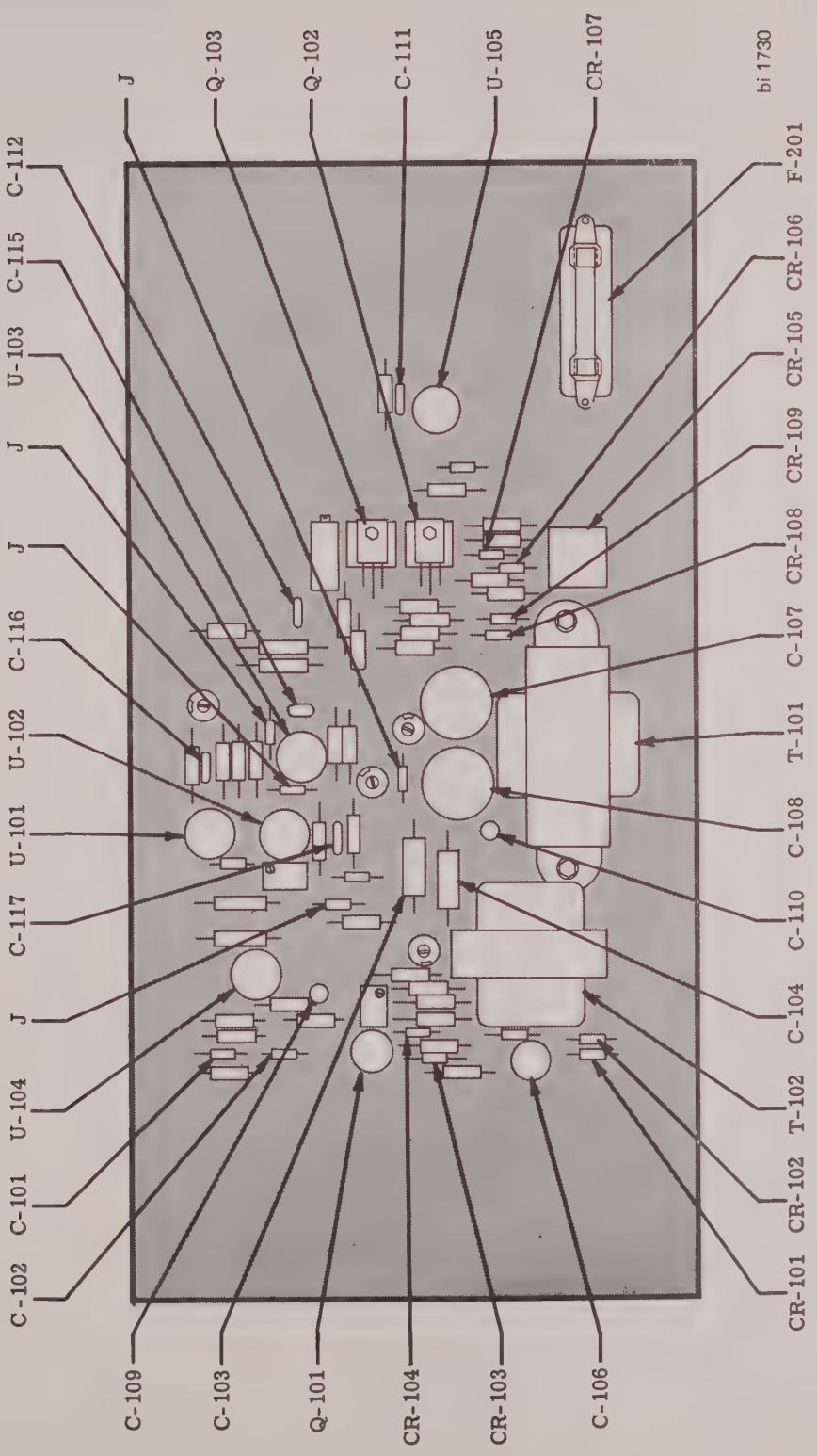
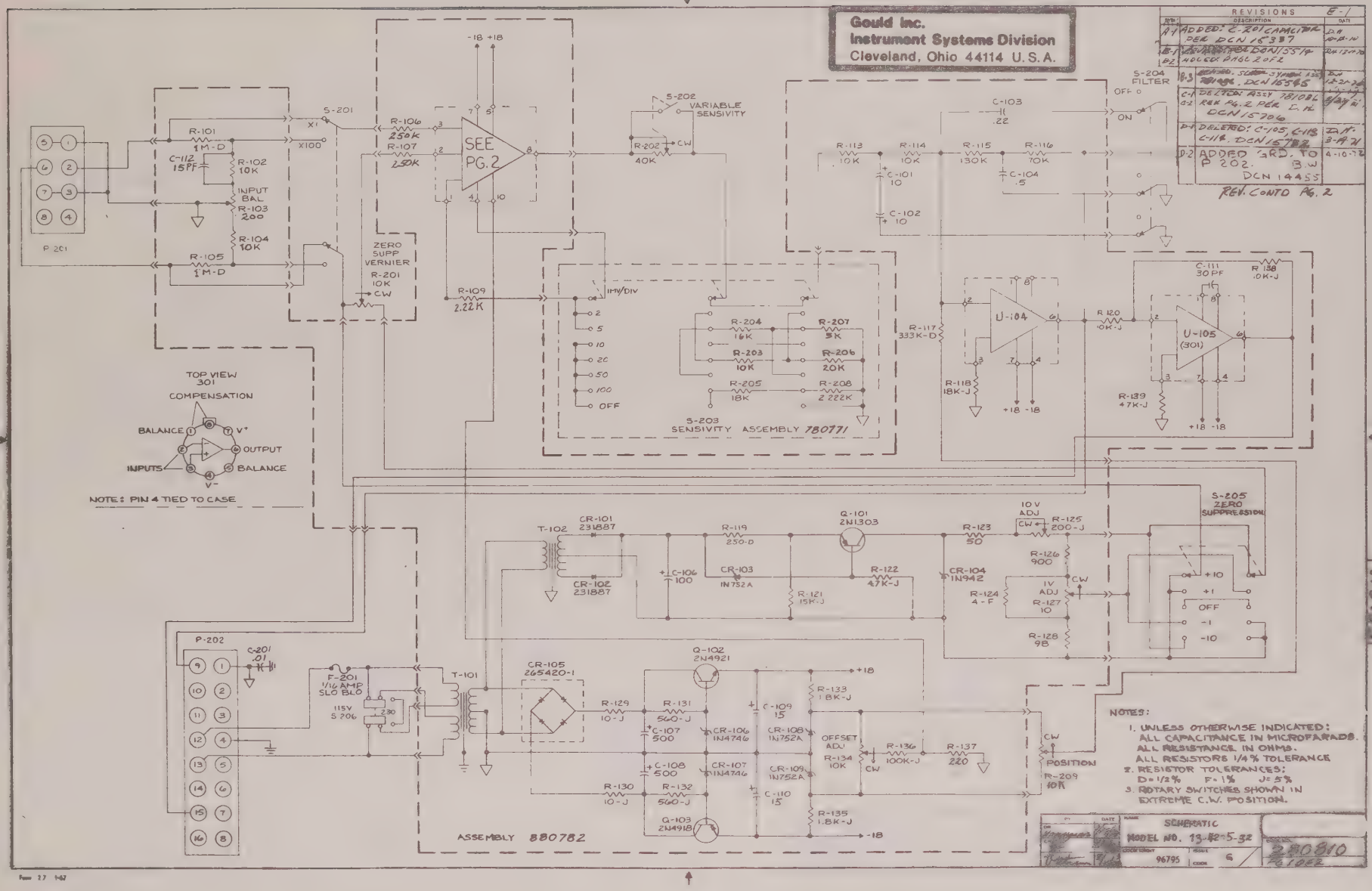
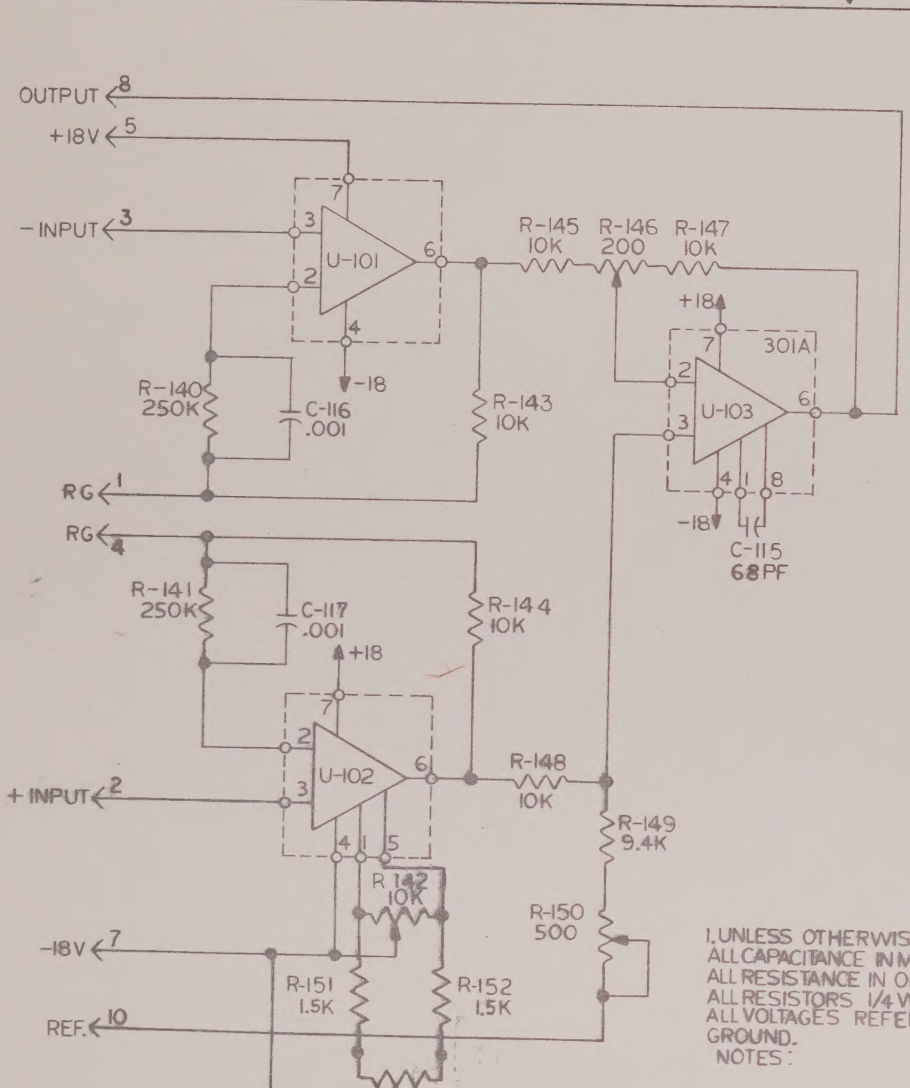


FIGURE 7-2B AMPLIFIER BOARD ASM. 880782


Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.
REVISIONS
S-201
S-202 VARIABLE SENSIVITY
S-203 SENSIVITY ASSEMBLY 780771
S-204 FILTER
S-205 ZERO SUPPRESSION
P 201
P-202
ZERO SUPP VERNIER
TOP VIEW 301
COMPENSATION
BALANCE
OUTPUT
INPUTS
NOTE: PIN 4 TIED TO CASE
SEE PG. 2
REV. CONTO PG. 2
ASSEMBLY 880782
SCHEMATIC
MODEL NO. 13-42-5-32
280810
NOTES:
1. UNLESS OTHERWISE INDICATED: ALL CAPACITANCE IN MICROFARADS. ALL RESISTANCE IN OHMS. ALL RESISTORS 1/4% TOLERANCE
2. RESISTOR TOLERANCES: D=1/2% F=1% J=5%
3. ROTARY SWITCHES SHOWN IN EXTREME C.W. POSITION.

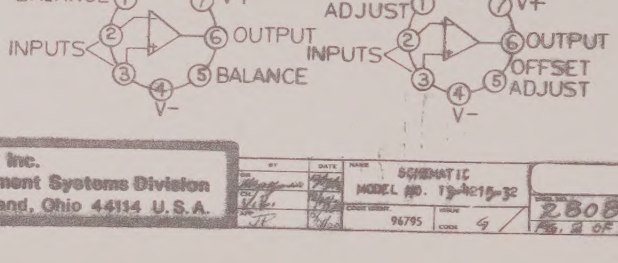
F 21055

REVISIONS		
E-1	REVISED PER DCN 16104	E-b 11-11-72
E-2	ADDED PIN 5 LABEL TO +18V TERM. PIN 7 LABEL TO -18V TERM. PER DCN 20508 10-30-73 SNOWDEN	NOV 6



1. UNLESS OTHERWISE INDICATED:
ALL CAPACITANCE IN MICROFARADS.
ALL RESISTANCE IN OHMS.
ALL RESISTORS 1/4 WATT.
ALL VOLTAGES REFERENCE GROUND.
NOTES:

TOP VIEWS



Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.

BY	DATE	NAME	SCHEMATIC
		MODEL NO.	13-4815-32
		CODE IDENT.	96795
		SIZE	A
		DWG. NO.	280810
		REV.	
		SHEET	2 OF 2

280810

Form 2.7 1-67

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Gould Inc., Instrument Systems Division
3631 Perkins Avenue, Cleveland, Ohio 44114
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